

CLAIMS

[1] A projection optical system for forming a reduced image of a first surface onto a second surface:

5 a first reflective imaging optical system for forming an intermediate image of the first surface and a second reflective imaging optical system for forming an image of the intermediate image onto the second surface;

10 the first reflective imaging optical system including a concave first reflector, a concave second reflector equipped with an aperture stop, a convex third reflector, and a concave fourth reflector successively as light enters from the first surface side;

15 the second reflective imaging optical system including a concave fifth reflector, a concave sixth reflector, a convex seventh reflector, and a concave eighth reflector successively as light enters from the first surface side.

[2] The projection optical system according to claim 1, wherein the fourth reflector is arranged in a space between the second and third reflectors.

[3] The projection optical system according to claim 2, wherein the 20 position of the fourth reflector satisfies the condition of

$$0.2 < d1/d2 < 0.8$$

where

d1 is the surface separation between the third and fourth reflectors, and

25 d2 is the surface separation between the second and third reflectors.

[4] The projection optical system according to one of claims 1 to 3, wherein absolute values of radii of curvature of all the reflectors fall within the range of 300 mm to 5000 mm.

[5] The projection optical system according to one of claims 1 to 4, 5 satisfying

$$400 \text{ mm} < R3 < 2000 \text{ mm}$$

where R3 is the radius of curvature of the third reflector.

[6] The projection optical system according to one of claims 1 to 5, 10 satisfying

$$0 < R2 < 3000 \text{ mm}$$

where R2 is the radius of curvature of the second reflector.

[7] The projection optical system according to one of claims 1 to 6, 15 satisfying

$$0 < R6 < 4000 \text{ mm}$$

where R6 is the radius of curvature of the sixth reflector.

[8] The projection optical system according to one of claims 1 to 7, 20 wherein the image-side numerical aperture NA is no less than 0.3.

[9] An exposure apparatus comprising an illumination system for illuminating a mask set on the first surface, and the projection optical system according to one of claims 1 to 8 for projecting and exposing a pattern of the mask onto a photosensitive substrate set on the second surface.

[10] An exposure apparatus according to claim 9, wherein the illumination system includes a light source for supplying an X-ray as exposure light, and projects and exposes the pattern of the mask onto the photosensitive substrate by moving the mask and photosensitive 25

substrate relative to the projection optical system.